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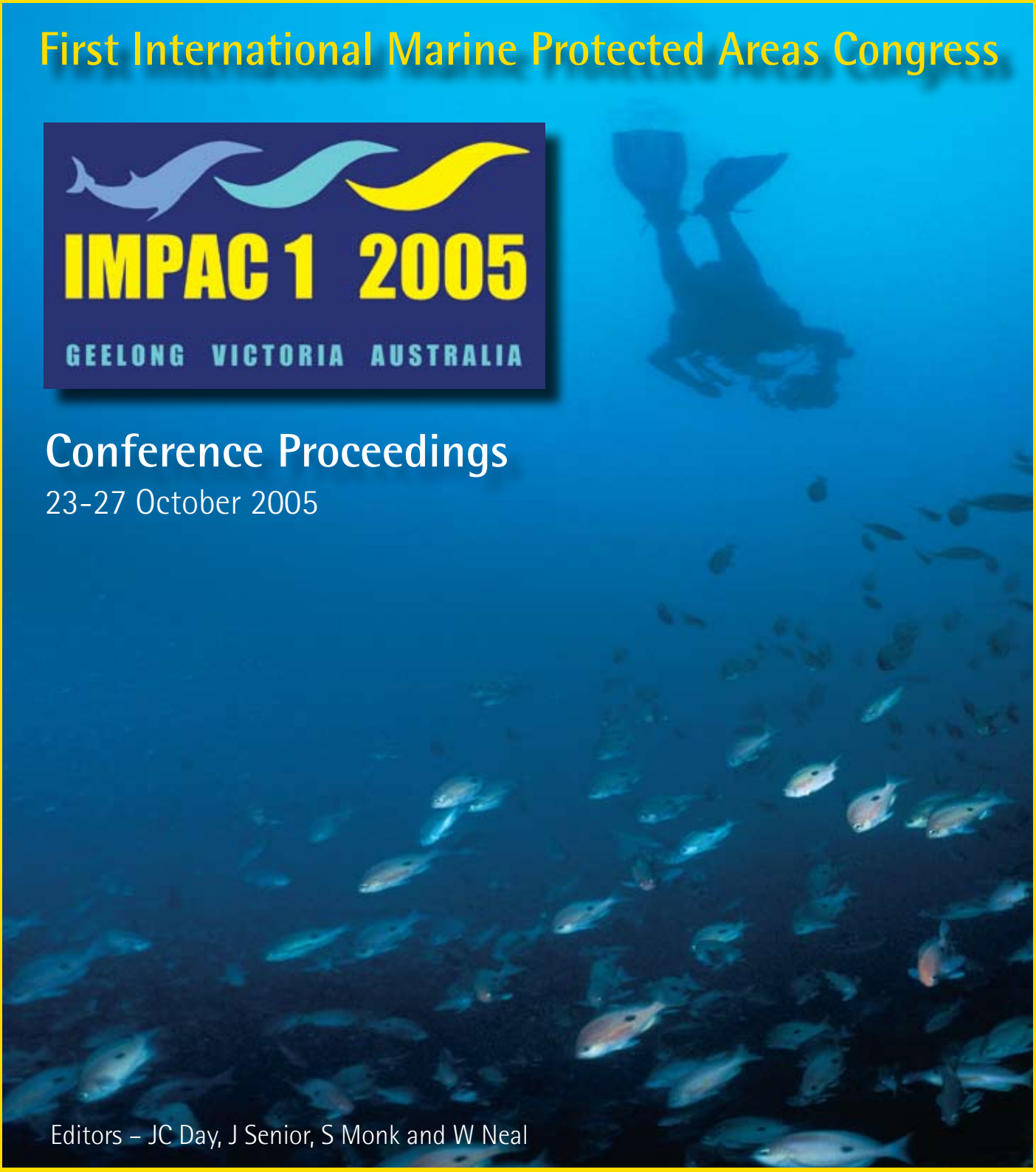

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019

THE DISTRIBUTION, ABUNDANCE, AND HABITAT RELATIONSHIPS OF DEEP-WATER DEMERSAL FISHES IN THE CORDELL BANK NATIONAL MARINE SANCTUARY (CBNMS), USA: THE IMPORTANCE OF ESTABLISHING SOUND BASELINES FOR FUTURE MONITORING.

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Preamble

Cordell Bank is a large (8x15 km) submerged granitic island at depths of 35-200 m on the edge of the continental shelf 100 km northwest of San Francisco. The Bank supports a wealth of marine life including a diverse deep-water fish and invertebrate community. In 1989 a 1362 km² area surrounding the Bank was designated as a National Marine Sanctuary to preserve this extraordinary ecosystem. Fisheries have impacted groundfish population numbers across California, which led to the 2002 closure of the rockfish fishery. Rockfish have been a dominant feature of Cordell Bank, yet little is known about local species patterns or the role habitat plays in structuring these assemblages.

In 2002, a quantitative survey of the Bank was undertaken using the two-person Delta submersible to examine fish assemblage structure, species distribution, abundance, and fish-habitat associations. Sixty strip-transects (2m x 15 minutes) were visually surveyed. Transects were videotaped and fish identified, sized and counted in situ by an observer; and later transcribed in the laboratory. As an initial framework for a long-term monitoring program a representative sub-sample of these transects were resurveyed in 2003 (n=38), 2004 (n=46), and are planned for 2005.

A variety of habitats were described, including pinnacles, rocky-reefs, boulder-fields, cobbles, sand, and mud. A diverse fish fauna, dominated by rockfish (95% of all fish) was documented. Spatial-position, depth, and substratum type were important variables explaining assemblage composition, and species patterns. Extremely large-sized commercial species were also present in deep boulder-fields suggesting that these areas may have provided a natural refuge from fishing.

Extended Abstract

In the United States, the National Marine Sanctuary Program, administered by NOAA's National Ocean Service (NOS), manages and protects 13 national marine sanctuaries and one coral reef ecosystem reserve. These Sanctuaries encompass more than 150,000 square miles of America's oceans and Great Lakes and have been designated for their ecological value, threatened and endangered species, habitats, and historic, archaeological, recreational and aesthetic resources. As the sixth National Marine Sanctuary, Cordell Bank National Marine Sanctuary (CBNMS) was designated in 1989 to protect a 1,362 km² area surrounding Cordell Bank, situated 32 kilometers offshore on the edge of the continental shelf, 100 km northwest of San Francisco. Cordell Bank is the northern most seamount on the California continental shelf. The Banks upper-most pinnacles lie 35 meters beneath the ocean's surface, while sanctuary waters on the west side of the Bank plunge precipitously to depths over 1,800 meters.

The CBNMS is situated in the middle of the California Current upwelling system, one of five major upwelling areas in the world. Deep light penetration combined with upwelling nutrients stimulates luxuriant phytoplankton growth in this region. As a consequence, the Sanctuary abounds with krill and is an important feeding ground for blue and humpback whales. These same food-rich waters are also a major foraging locality for a plethora of marine mammals (e.g. Dall's porpoise), birds (e.g. albatross, shearwaters), and countless other migratory and resident marine species. At the heart of the sanctuary, the Bank's steep-sided ridges, narrow pinnacles, and broken bedrock habitats support diverse communities including algae and numerous invertebrates that carpet the substratum. Groundfishes, including commercially and recreationally sought-after rockfishes, are also abundant on and around the Bank. Until recently commercial long-liners and trawlers, along with recreational sports fishermen, fished the bank and surrounding waters for a variety of groundfish – commonly targeting rockfish species. Declines in population numbers of previously abundant species (e.g. Bocaccio, Yelloweye and Canary Rockfishes) led to the closure of the groundfish fishery in 2002. In 2003 Cordell Bank was designated as one of several 'Groundfish Conservation Areas' by the National Marine Fisheries Service (NMFS), closing the Bank to all groundfish fishing.

To manage this extraordinary ecosystem, it was deemed essential to establish a sound knowledge and understanding of both the pelagic and benthic communities within the Sanctuary. The establishment of baseline and monitoring surveys for both the pelagic and benthic systems were assigned high priorities in the CBNMS management plan. Given the importance of ground-fisheries both locally and coast-wide, benthic surveys were also required to provide sound knowledge on both the composition and abundance of groundfishes, and the degree of species-habitat relationships within the Sanctuary. As a result, in 2002 a quantitative benthic survey using an occupied (two-person) *Delta* submersible (http://www.deltaoceanographics.com), was initiated to: i) provide an inventory of demersal species present within the Sanctuary, ii) characterize the benthic habitats and their faunal communities, with specific attention to groundfishes, and iii) collect baseline and ongoing monitoring data (Bank habitats were resurveyed in 2003, and 2004) to evaluate the effectiveness of the Sanctuary in managing these resources.

To characterize the benthos and macro-fauna of Cordell Bank, researchers from CBNMS, NMFS Santa Cruz, and Washington State University undertook an intensive 12-day survey of the Bank during the boreal Fall (ie. September and October) of 2002. 31 dives sampling 60 strip-transects (2m wide by 15 minutes in duration) were allocated over the breadth of the Bank and surrounding habitats. Dives were

made during daylight hours, and surveyed a variety of habitats at depths ranging from 34-350 m. During transects, the submersible traversed 1-2 m above the seafloor at speeds of 0.4-0.9 knots. Each transect was videotaped by an externally mounted digital video camera, while the observer's counts and descriptions were recorded *in situ* on audiotape. Submersible depth and altitude were recorded by a CTD mounted to the hull of the submersible. Demersal fish within each transect were identified, sized and counted *in situ* by an observer. Paired lasers, set 20 cm apart and projected into the field of view, were used to gauge transect width and fish sizes. Fish information was later transcribed in the laboratory. Seafloor habitats were characterized and delineated by post-processing of the videotape (following the protocols of Stein *et al.* 1992 and Yoklavich *et al.* 2000), as was the identification and enumeration of the macro-invertebrate and algal fauna (protocols of Tissot *et al*. 2004). To determine if the assemblage characterization (e.g. species composition and abundance) made during this survey was annually consistent and therefore useful as a baseline description, and in order to scrutinize an initial framework for a long-term monitoring program, a representative sub-sample of the 2002 transects were resurveyed in 2003 (n=38) and 2004 (n=46).

In this presentation we focus on the habitat and groundfish components of the survey. To examine the Bank's geography relative to the availability and correlation of habitat variables (e.g., substratum type, depth, habitat patchiness), we categorized the data into Bank-locations designated by grid locations. Substratum types were spatially structured and strongly correlated (often confounded) with depth and Bank location. For example, central regions of the Bank predictably had the shallowest depths (34-55 m), and were characterized by high relief rocky pinnacles. As depth increased away from the center of the Bank (i.e. 70-100m), habitats were multifaceted and varied relative to Bank aspect. Habitats at these depths included boulder fields (SW), boulder-rock areas often cut by sand channels (SW, NE, CE), and white sands disrupted by outcrops of cobbles and boulders (NE, CE, SE). Adjacent soft-sediments also varied relative to aspect. On the eastern side of the Bank, sediments were characterized by sculptured coarse white sands (60-120m), while the western side of the Bank was characterized by deep mud slopes (150-350m) with vertical mud walls in some areas.

An abundant and diverse groundfish fauna was documented from the Cordell Bank and surrounding habitats during the 2002 survey. A total of 87,078 groundfishes, representing 70 species (or species-groups) and 21 families, were recorded. Rockfishes were the most dominant fishes, accounting for 27 species and 95% of all fish. Of these, young-of-year (YOY) rockfishes were the most numerous, accounting for 64% of all rockfishes, and 61% of all groundfishes. Habitat type, depth, and Bank location were important variables (although these variables were often confounded) in explaining the distribution and abundance of these species. For example, the shallow, high-relief, rocky pinnacle regions of the central Bank were dominated by schooling species such as YOY rockfish, pygmy (*Sebastes wilsoni*), widow (*S. entomelas*), and yellowtail (*S. flavidus*) rockfishes, along with more solitary species, such as rosy rockfish (*S. rosaceus*). Mid-depth boulder-rock habitats were characterized by the numerically dominant pygmy, squarespot (*S. hopkinsi*), and yellowtail (*S. flavidus*) rockfishes, as well as rosy (*S. rosaceous*), and greenspotted (*S. chlorostictus*) rockfishes, lingcod (*Ophiodon elongates*), painted greenling (*Oxylebius pictus*), and blackeye goby (*Coryphopterus nicholsi*). Boulder habitats at the edge of the Bank also contained higher densities of large commercially important species, such as bocaccio (*S. paucispinis*), yelloweye (*S. ruberrimus*), and canary (*S. pinniger*) rockfishes, and Lingcod. Soft sediment habitats also varied in their species assemblages. Coarse sands were characterized by sanddabs (family Bothidae, genus *Citharichthys*), poachers (family Agonidae), and combfish (family Zaniolepididae). In contrast, mud habitats (200-300m) were characterized by flatfish, spotted ratfish (*Hydrolagus colliei*), poachers, combfish, and stripetail rockfish (*S. saxicola*). In addition to mud-associated species, deep vertical mud walls had high numbers of grotto-dwelling hagfish.

Sampling in 2003 and 2004 indicated that assemblage composition was stable over the three years. However, the high abundance of the YOY rockfish cohort in 2002 was not reflected in counts of juveniles in 2003 and 2004. It is unclear whether these young fish moved or died. New YOY rockfish cohorts however were recorded in 2003 and 2004. These results reveal that Cordell Bank encompasses a diverse array of seafloor habitats that support rich benthic communities. Rockfishes dominate the fish fauna in abundance and species richness. Species were strongly associated with specific habitat components, but these were also correlated or confounded with Bank location. Information from these surveys provide a sound knowledge base that will enable Sanctuary caretakers and stakeholders to better understand and manage this valuable resource and help to better predict the potential and realized effects of natural or anthropogenic impacts on the health and dynamics of this extraordinary system.

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